

WHAT IS CLAIMED IS:

1. An image formation apparatus having an arrangement so that a discomfort probability P, calculated from an expression (a) , fulfills a condition (b), wherein

the discomfort probability P is calculated using a sound pressure level value, a  
5 loudness value of a psycho-acoustics parameter, a sharpness value, a tonality value,  
and an impulsiveness value obtained from operation noise at a position with a distance  
from an end surface of the image formation apparatus,

$$\hat{P}_{im} = 1/\{1 + \exp[-z]\} \quad \dots (a)$$

$$\hat{P}_{im} \leq 0.2725 \cdot \ln(\text{ppm}) - 0.6331 \quad \dots (b)$$

10 where

$$z = A \times \text{sound pressure level } i + B \times \text{loudness } i + C \times \text{sharpness } i$$

$$+ D \times \text{tonality } i + E \times \text{impulsiveness } i + F$$

$$i = 1, 2, 3, \dots, n$$

A, B, C, D, and E are regression coefficients of parameters, and F is intercept,

15 and A, B, C, D, E, and F satisfy the inequalities

$$0.142 \leq A \leq 0.183$$

$$0.300 \leq B \leq 0.389$$

$$1.097 \leq C \leq 1.265$$

$$9.818 \leq D \leq 11.516$$

20  $2.588 \leq E \leq 3.240$

$$-18.844 \leq F \leq 14.968$$

ppm is a printing speed per minute for A4 horizontal size recording medium.

2. The image formation apparatus according to claim 1, wherein  
values of A to F are in a range of  $\pm 2\sigma$ , where  $\sigma$  is standard error, with respect  
to an estimate value of each coefficient.

5 3. The image formation apparatus according to claim 1, wherein  
a multiple logistic regression model

$$\hat{P}_{ij} = 1 / \left\{ 1 + \exp \left[ - \left( \sum_{l=1}^L b_l (x_{li} - x_{lj}) \right) \right] \right\},$$

where

$b_l$  is regression coefficient

10  $x_{li}$  and  $x_{lj}$  are psychological acoustic parameter values of sounds that are  
compared in pair

$i = 1, 2, 3, \dots, n$

$j = 1, 2, 3, \dots, n$

$l = 1, 2, 3, \dots, L,$

15 that predicts a probability of dominance of sound based on a paired comparison of  
sounds transforms the expression (a) for calculating the discomfort probabilities into an  
expression that predicts a discomfort probability of single noise by using an average  
value of psycho-acoustics parameter values of whole samples used to derive a  
regression model expression.

20

4. The image formation apparatus according to claim 1, comprising a  
higher-frequency-component reducing unit that reduces a  
higher-frequency-component to fulfill the condition (b).

5. The image formation apparatus according to claim 4, wherein  
the higher-frequency-component reducing unit includes a guiding member in  
a medium conveying unit and a sliding noise reducing unit that reduces sliding of a  
recording medium.
- 5 6. The image formation apparatus according to claim 1, comprising an  
impulse-noise reducing unit that reduces impulse noise to fulfill the condition (b).
7. The image formation apparatus according to claim 6, wherein  
10 the impulse -noise reducing unit includes a medium conveyance control unit  
that controls electromagnetic clutches, each provided on each of routes for conveying  
a recording medium, having a plurality of medium feed trays, such that only  
electromagnetic clutches positioned on or above a used medium feed tray or above  
operate.
- 15 8. The image formation apparatus according to claim 1, wherein  
the discomfort probability (P), in at least a direction of an operating section, of  
the sound generated by the image formation apparatus is at a permissible level or  
below, at a distance of  $1.00 \pm 0.03$  meters from an end surface of the image formation  
20 apparatus, and at a height of  $1.20 \pm 0.03$  meters above the floor or  $1.50 \pm 0.03$  meters  
above the floor.
9. The image formation apparatus according to claim 1, wherein  
an average value of the discomfort probability (P), in four directions of front,  
25 back, left, and right sides, of the sound generated by the image formation apparatus is

at a permissible level or below, at a distance of  $1.00 \pm 0.03$  meters from an end surface of the image formation apparatus, and at a height of  $1.20 \pm 0.03$  meters above the floor or  $1.50 \pm 0.03$  meters above the floor.

5 10. The image formation apparatus according to claim 1, wherein  
the discomfort probability (P), on at least one side, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of  $1.00 \pm 0.03$  meters from an end surface of the image formation apparatus, and at a height of  $1.20 \pm 0.03$  meters above the floor or  $1.50 \pm 0.03$  meters above the floor.

10

11. The image formation apparatus according to claim 1, wherein  
the discomfort probability (P), on all the four sides, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of  $1.00 \pm 0.03$  meters from an end surface of the image formation apparatus, and at a height of  
15  $1.20 \pm 0.03$  meters above the floor or  $1.50 \pm 0.03$  meters above the floor.

12. An image formation apparatus having an arrangement so that a discomfort probability P, calculated from an expression (c), fulfills a condition (b), wherein  
the discomfort probability P is calculated using a sound pressure level value, a  
20 loudness value of a psycho-acoustics parameter, a sharpness value, a tonality value, and an impulsiveness value obtained from operation noise at a position with a distance from an end surface of the image formation apparatus,

$$\hat{P}_{i\omega} = 1 / \left\{ 1 + \exp \left[ \begin{array}{l} 16.90601 - 0.1625723 \chi_{\text{sound pressure level}} \\ - 0.34475769 \chi_{\text{loudness } i} - 1.18093783 \chi_{\text{sharpness } i} \\ - 10.6669829 \chi_{\text{tonality } i} - 2.91380546 \phi_{\text{impulse } i} \\ \pm 2\hat{\sigma} \end{array} \right] \right\} \dots (c)$$

$$\hat{P}_{im} \leq 0.2725 \cdot \ln(\text{ppm}) - 0.6331 \quad \dots (b)$$

where

$$i = 1, 2, 3, \dots, n$$

$\sigma$  is standard error

5 ppm is a printing speed per minute for A4 horizontal size recording medium.

13. The image formation apparatus according to claim 12, wherein  
the standard error  $\sigma$  is 0.839.

10 14. The image formation apparatus according to claim 12, wherein  
a multiple logistic regression model

$$\hat{P}_{ij} = 1 / \left\{ 1 + \exp \left[ - \left( \sum_{l=1}^L b_l (x_{li} - x_{lj}) \right) \right] \right\},$$

where

$b_l$  is regression coefficient

15  $x_{li}$  and  $x_{lj}$  are psychological acoustic parameter values of sounds that are  
compared in pair

$$i = 1, 2, 3, \dots, n$$

$$j = 1, 2, 3, \dots, n$$

$$l = 1, 2, 3, \dots, L,$$

20 that predicts a probability of dominance of sound based on a paired comparison of  
sounds transforms the expression (c) for calculating the discomfort probabilities into an  
expression that predicts a discomfort probability of single noise by using an average  
value of psycho-acoustics parameter values of whole samples used to derive a  
regression model expression.

15. The image formation apparatus according to claim 12, comprising a higher-frequency-component reducing unit that reduces a higher-frequency-component to fulfill the condition (b).
- 5 16. The image formation apparatus according to claim 15, wherein the higher-frequency-component reducing unit includes a guiding member in a medium conveying unit and a sliding noise reducing unit that reduces sliding of a recording medium.
- 10 17. The image formation apparatus according to claim 12, comprising an impulse-noise reducing unit that reduces impulse noise to fulfill the condition (b).
18. The image formation apparatus according to claim 17, wherein the impulse -noise reducing unit includes a medium conveyance control unit
- 15 that controls electromagnetic clutches, each provided on each of routes for conveying a recording medium, having a plurality of medium feed trays, such that only electromagnetic clutches positioned on or above a used medium feed tray or above operate.
- 20 19. The image formation apparatus according to claim 12, wherein the discomfort probability (P), in at least a direction of an operating section, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of  $1.00 \pm 0.03$  meters from an end surface of the image formation apparatus, and at a height of  $1.20 \pm 0.03$  meters above the floor or  $1.50 \pm 0.03$  meters
- 25 above the floor.

20. The image formation apparatus according to claim 12, wherein  
an average value of the discomfort probability (P), in four directions of front,  
back, left, and right sides, of the sound generated by the image formation apparatus is  
at a permissible level or below, at a distance of  $1.00 \pm 0.03$  meters from an end surface  
5 of the image formation apparatus, and at a height of  $1.20 \pm 0.03$  meters above the floor  
or  $1.50 \pm 0.03$  meters above the floor.
21. The image formation apparatus according to claim 12, wherein  
the discomfort probability (P), on at least one side, of the sound generated by  
10 the image formation apparatus is at a permissible level or below, at a distance of  $1.00 \pm$   
 $0.03$  meters from an end surface of the image formation apparatus, and at a height of  
 $1.20 \pm 0.03$  meters above the floor or  $1.50 \pm 0.03$  meters above the floor.
22. The image formation apparatus according to claim 12, wherein  
15 the discomfort probability (P), on all the four sides, of the sound generated by  
the image formation apparatus is at a permissible level or below, at a distance of  $1.00 \pm$   
 $0.03$  meters from an end surface of the image formation apparatus, and at a height of  
 $1.20 \pm 0.03$  meters above the floor or  $1.50 \pm 0.03$  meters above the floor.
- 20 23. An image formation apparatus having an arrangement so that a discomfort  
probability P, calculated from an expression (d), fulfills a condition (b), wherein  
the discomfort probability P is calculated using a sound pressure level value, a  
loudness value of a psycho-acoustics parameter, a sharpness value, a tonality value,  
and an impulsiveness value obtained from operation noise at a position with a  
25 predetermined distance from an end surface of the image formation apparatus,

$$\hat{P}_{iw} = 1 / \left\{ 1 + \exp \left[ \begin{array}{l} 16.90601 - 0.1625723 \chi_{\text{sound pressure level}} \\ - 0.34475769 \chi_{\text{loudness } i} - 1.18093783 \chi_{\text{sharpness } i} \\ - 10.6669829 \chi_{\text{tonality } i} - 2.91380546 \chi_{\text{impulse } i} \end{array} \right] \right\} \dots (d)$$

$$\hat{P}_{iw} \leq 0.2725 \cdot \ln(\text{ppm}) - 0.6331 \dots (b)$$

where

$$i = 1, 2, 3, \dots, n$$

5 ppm is a printing speed per minute for A4 horizontal size recording medium.

24. The image formation apparatus according to claim 23, wherein  
a multiple logistic regression model

$$\hat{P}_{ij} = 1 / \left\{ 1 + \exp \left[ - \left( \sum_{l=1}^L b_l (x_{li} - x_{lj}) \right) \right] \right\},$$

10 where

$b_l$  is regression coefficient

$x_{li}$  and  $x_{lj}$  are psychological acoustic parameter values of sounds that are  
compared in pair

$$i = 1, 2, 3, \dots, n$$

15  $j = 1, 2, 3, \dots, n$

$$l = 1, 2, 3, \dots, L,$$

that predicts a probability of dominance of sound based on a paired comparison of  
sounds transforms the expression (d) for calculating the discomfort probabilities into an  
expression that predicts a discomfort probability of single noise by using an average  
20 value of psycho-acoustics parameter values of whole samples used to derive a  
regression model expression.



25. The image formation apparatus according to claim 24, comprising a higher-frequency-component reducing unit that reduces a higher-frequency-component to fulfill the condition (b).

5 26. The image formation apparatus according to claim 25, wherein the higher-frequency-component reducing unit includes a guiding member in a medium conveying unit and a sliding noise reducing unit that reduces sliding noise of a recording medium.

10 27. The image formation apparatus according to claim 23, comprising an impulse-noise reducing unit that reduces impulse noise to fulfill the condition (b).

28. The image formation apparatus according to claim 27, wherein the impulse-noise reducing unit includes a medium conveyance control unit  
15 that controls electromagnetic clutches, each provided on each of routes for conveying a recording medium, having a plurality of medium feed trays, such that only electromagnetic clutches positioned on or above a used medium feed tray operate.

29. The image formation apparatus according to claim 23, wherein  
20 the discomfort probability P, in at least a direction of an operating section, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of  $1.00 \pm 0.03$  meters from an end surface of the image formation apparatus, and at a height of  $1.20 \pm 0.03$  meters above the floor or  $1.50 \pm 0.03$  meters above the floor.

25

30. The image formation apparatus according to claim 23, wherein  
an average value of the discomfort probability  $P$ , in four directions of front,  
back, left, and right sides, of the sound generated by the image formation apparatus is  
at a permissible level or below, at a distance of  $1.00 \pm 0.03$  meters from an end surface  
5 of the image formation apparatus, and at a height of  $1.20 \pm 0.03$  meters above the floor  
or  $1.50 \pm 0.03$  meters above the floor.
31. The image formation apparatus according to claim 23, wherein  
the discomfort probability  $P$ , on at least one side, of the sound generated by  
10 the image formation apparatus is at a permissible level or below, at a distance of  $1.00 \pm$   
 $0.03$  meters from an end surface of the image formation apparatus, and at a height of  
 $1.20 \pm 0.03$  meters above the floor or  $1.50 \pm 0.03$  meters above the floor.
32. The image formation apparatus according to claim 23, wherein  
15 the discomfort probability  $P$ , on all the four sides, of the sound generated by  
the image formation apparatus is at a permissible level or below, at a distance of  $1.00 \pm$   
 $0.03$  meters from an end surface of the image formation apparatus, and at a height of  
 $1.20 \pm 0.03$  meters above the floor or  $1.50 \pm 0.03$  meters above the floor.
- 20 33. An image formation apparatus having an arrangement so that a discomfort  
probability  $P$ , calculated from an expression (e), fulfills a condition (f), wherein  
the discomfort probability  $P$  is calculated using a sound pressure level value  
(A) in decibels, a loudness value of a psycho-acoustics parameter, a sharpness value,  
a tonality value, an impulsiveness value, and a printing speed ppm, obtained from  
25 operation noise at a position with a distance from an end surface of the image

formation apparatus,

$$P = \frac{1}{1 + \exp(-z)} \quad \dots (e)$$

$$P \leq 0.1728e^{0.0065 \text{ ppm}} \quad \dots (f)$$

where

5 
$$z = A \times \text{sound pressure level } i + B \times \text{loudness } i + C \times \text{sharpness } i$$
$$+ D \times \text{tonality } i + E \times \text{impulsiveness } i + F \times \text{ppm } i + G$$
$$i = 1, 2, 3, \dots, n$$

A, B, C, D, E, and F are regression coefficients of parameters, and G is intercept, and A, B, C, D, E, F, and G satisfy the inequalities

10 
$$0.10547717 \leq A \leq 0.15069022$$
$$0.40687921 \leq B \leq 0.53399976$$
$$0.99138725 \leq C \leq 1.166331$$
$$8.38547981 \leq D \leq 10.1721249$$
$$2.57373312 \leq E \leq 3.21686388$$

15 
$$-0.020344 \leq F \leq 0.0106576$$
$$-17.49359273 \leq G \leq 12.70308101$$

ppm is a printing speed per minute for A4 horizontal size recording medium.

34. The image formation apparatus according to claim 33, wherein
- 20 values of A to F are in a range of  $\pm 2\sigma$ , where  $\sigma$  is standard error, with respect to an estimate value of each coefficient.

35. The image formation apparatus according to claim 33, wherein  
a multiple logistic regression model

$$\hat{P}_{ij} = 1 / \left\{ 1 + \exp \left[ - \left( \sum_{l=1}^L b_l (x_{li} - x_{lj}) \right) \right] \right\},$$

where

5  $b_l$  is regression coefficient

$x_{li}$  and  $x_{lj}$  are psychological acoustic parameter values of sounds that are  
compared in pair

$i = 1, 2, 3, \dots, n$

$j = 1, 2, 3, \dots, n$

10  $l = 1, 2, 3, \dots, L,$

that predicts a probability of dominance of sound based on a paired comparison of  
sounds transforms the expression (e) for calculating the discomfort probabilities into an  
expression that predicts a discomfort probability of single noise by using an average  
value of psycho-acoustics parameter values of whole samples that are used to derive  
15 a regression model expression.

36. The image formation apparatus according to claim 33, wherein

the discomfort probability  $P$ , in at least a direction of an operating section, of  
the sound generated by the image formation apparatus is at a permissible level or  
20 below, at a distance of  $1.00 \pm 0.03$  meters from an end surface of the image formation  
apparatus, and at a height of  $1.20 \pm 0.03$  meters above the floor or  $1.50 \pm 0.03$  meters  
above the floor.

37. The image formation apparatus according to claim 33, wherein  
an average value of the discomfort probability  $P$ , in four directions of front,  
back, left, and right sides, of the sound generated by the image formation apparatus is  
at a permissible level or below, at a distance of  $1.00 \pm 0.03$  meters from an end surface  
5 of the image formation apparatus, and at a height of  $1.20 \pm 0.03$  meters above the floor  
or  $1.50 \pm 0.03$  meters above the floor.
38. The image formation apparatus according to claim 33, wherein  
the discomfort probability  $P$ , on at least one side, of the sound generated by  
10 the image formation apparatus is at a permissible level or below, at a distance of  $1.00 \pm$   
 $0.03$  meters from an end surface of the image formation apparatus, and at a height of  
 $1.20 \pm 0.03$  meters above the floor or  $1.50 \pm 0.03$  meters above the floor.
39. The image formation apparatus according to claim 33, wherein  
15 the discomfort probability  $P$ , on all the four sides, of the sound generated by  
the image formation apparatus is at a permissible level or below, at a distance of  $1.00 \pm$   
 $0.03$  meters from an end surface of the image formation apparatus, and at a height of  
 $1.20 \pm 0.03$  meters above the floor or  $1.50 \pm 0.03$  meters above the floor.
- 20 40. The image formation apparatus according to claim 33, comprising a  
higher-frequency-component reducing unit that reduces a  
higher-frequency-component to fulfill the condition (f).

41. The image formation apparatus according to claim 33, wherein  
the higher-frequency-component reducing unit includes a guiding member in  
a medium conveying unit and a sliding noise reducing unit that reduces sliding noise of  
the recording medium.
- 5
42. The image formation apparatus according to claim 33, comprising an  
impulse-noise reducing unit that reduces impulse noise to fulfill the condition (f).
43. The image formation apparatus according to claim 42, wherein  
10 the impulse noise reducing unit includes a medium conveyance control unit  
that controls electromagnetic clutches, each provided on each of routes for conveying  
a recording medium each having a plurality of medium feed trays, such that only  
electromagnetic clutches positioned on a used medium feed tray or above operate.
- 15 44. The image formation apparatus according to claim 33, comprising a  
pure-tone-component reducing unit that reduces a pure-tone-component to fulfill the  
condition (f).
45. The image formation apparatus according to claim 44, wherein  
20 the pure-tone-component reducing unit includes a charging noise reducing  
unit that reduces charging noise generated during a charging due to an AC bias.
46. The image formation apparatus according to claim 45, wherein  
the charging noise reducing unit has an eigen frequency of an image holder  
25 that is different from a frequency obtained by multiplying a natural number to a

frequency of the AC bias.

47. The image formation apparatus according to claim 45, wherein  
the charging noise reducing unit has a sound absorbing member inside an  
5 image holder.

48. The image formation apparatus according to claim 45, wherein  
the charging noise reducing unit has an oscillation control member inside an  
image holder.

10

49. The image formation apparatus according to claim 33, comprising a guiding  
member in a route of a recording medium, wherein guiding member the includes a  
flexible sheet having a bent end edge portion or having a thickness of one half or  
smaller to control the conveying route of the recording medium.

15

50. An image formation apparatus having an arrangement so that a discomfort  
probability P, calculated from an expression (g), fulfills a condition (f), wherein  
the discomfort probability P is calculated using a sound pressure level value  
(A) in decibels, a loudness value of a psycho-acoustics parameter, a sharpness value,  
20 a tonality value, an impulsiveness value, and a printing speed ppm, obtained from  
operation noise at a position with a predetermined distance from an end surface of the  
image formation apparatus,

$$P = \frac{1}{1 + \exp(-z \pm 2\sigma)} \quad \dots (g)$$

$$P \leq 0.1728e^{0.0065 \text{ ppm}} \quad \dots (f)$$

where

$$\begin{aligned} z = & 0.12808364 \times \text{sound pressure level } i + 0.47043907 \times \text{loudness } i \\ & + 1.07885872 \times \text{sharpness } i + 9.27879937 \times \text{tonality } i \\ & + 2.89529674 \times \text{impulsiveness } i - 0.0155008 \times \text{ppm } i - 15.09832827 \end{aligned}$$

5  $i = 1, 2, 3, \dots, n$

$\sigma$  is standard error = 0.871894

ppm is a printing speed per minute for A4 horizontal size recording medium.

51. The image formation apparatus according to claim 50, wherein  
10 a multiple logistic regression model

$$\hat{P}_{ij} = 1 / \left\{ 1 + \exp \left[ - \left( \sum_{l=1}^L b_l (x_{li} - x_{lj}) \right) \right] \right\},$$

where

$b_l$  is regression coefficient

$x_{li}$  and  $x_{lj}$  are psychological acoustic parameter values of sounds that are

- 15 compared in pair

$i = 1, 2, 3, \dots, n$

$j = 1, 2, 3, \dots, n$

$l = 1, 2, 3, \dots, L,$

- that predicts a probability of dominance of sound based on a paired comparison of  
20 sounds transforms the expression (e) for calculating the discomfort probabilities into an  
expression that predicts a discomfort probability of single noise by using an average  
value of psycho-acoustics parameter values of whole samples that are used to derive  
a regression model expression.



52. The image formation apparatus according to claim 50, wherein  
the discomfort probability  $P$ , in at least a direction of an operating section, of  
the sound generated by the image formation apparatus is at a permissible level or  
below, at a distance of  $1.00 \pm 0.03$  meters from an end surface of the image formation  
5 apparatus, and at a height of  $1.20 \pm 0.03$  meters above the floor or  $1.50 \pm 0.03$  meters  
above the floor.

53. The image formation apparatus according to claim 50, wherein  
an average value of the discomfort probability  $P$ , in four directions of front,  
10 back, left, and right sides, of the sound generated by the image formation apparatus is  
at a permissible level or below, at a distance of  $1.00 \pm 0.03$  meters from an end surface  
of the image formation apparatus, and at a height of  $1.20 \pm 0.03$  meters above the floor  
or  $1.50 \pm 0.03$  meters above the floor.

15 54. The image formation apparatus according to claim 50, wherein  
the discomfort probability  $P$ , on at least one side, of the sound generated by  
the image formation apparatus is at a permissible level or below, at a distance of  $1.00 \pm$   
 $0.03$  meters from an end surface of the image formation apparatus, and at a height of  
 $1.20 \pm 0.03$  meters above the floor or  $1.50 \pm 0.03$  meters above the floor.

20

55. The image formation apparatus according to claim 50, wherein  
the discomfort probability  $P$ , on all the four sides, of the sound generated by  
the image formation apparatus is at a permissible level or below, at a distance of  $1.00 \pm$   
 $0.03$  meters from an end surface of the image formation apparatus, and at a height of  
25  $1.20 \pm 0.03$  meters above the floor or  $1.50 \pm 0.03$  meters above the floor.

56. The image formation apparatus according to claim 50, comprising a higher-frequency-component reducing unit that reduces a higher-frequency-component to fulfill the condition (f).

5 57. The image formation apparatus according to claim 56, wherein the higher-frequency-component reducing unit includes a guiding member in a medium conveying unit and a sliding noise reducing unit that reduces sliding noise of the recording medium.

10 58. The image formation apparatus according to claim 50, comprising an impulse-noise reducing unit that reduces impulse noise to fulfill the condition (f).

59. The image formation apparatus according to claim 58, wherein the impulse noise reducing unit includes a medium conveyance control unit  
15 that controls electromagnetic clutches, each provided on each of routes for conveying a recording medium each having a plurality of medium feed trays, such that only electromagnetic clutches positioned on a used medium feed tray or above operate.

60. The image formation apparatus according to claim 50, comprising a  
20 pure-tone-component reducing unit that reduces a pure-tone-component to fulfill the condition (f).

61. The image formation apparatus according to claim 60, wherein the pure-tone-component reducing unit includes a charging noise reducing  
25 unit that reduces charging noise generated during a charging due to an AC bias.

62. The image formation apparatus according to claim 61, wherein  
the charging noise reducing unit has an eigen frequency of an image holder  
that is different from a frequency obtained by multiplying a natural number to a  
frequency of the AC bias.

5

63. The image formation apparatus according to claim 61, wherein  
the charging noise reducing unit has a sound absorbing member inside an  
image holder.

10 64. The image formation apparatus according to claim 61, wherein  
the charging noise reducing unit has an oscillation control member inside an  
image holder.

65. The image formation apparatus according to claim 50, comprising a guiding  
15 member in a route of a recording medium, wherein guiding member the includes a  
flexible sheet having a bent end edge portion or having a thickness of one half or  
smaller to control the conveying route of the recording medium.

66. An image formation apparatus having an arrangement so that a discomfort  
20 probability  $P$ , calculated from an expression (h), fulfills a condition (f), wherein  
the discomfort probability  $P$  is calculated using a sound pressure level value  
(A) in decibels, a loudness value of a psycho-acoustics parameter, a sharpness value,  
a tonality value, an impulsiveness value, and a printing speed ppm, obtained from  
operation noise at a position with a predetermined distance from an end surface of the  
25 image formation apparatus,

$$P = \frac{1}{1 + \exp(-z)} \quad \dots (h)$$

$$P \leq 0.1728e^{0.0065 \text{ ppm}} \quad \dots (f)$$

where

$$z = 0.12808364 \times \text{sound pressure level } i + 0.47043907 \times \text{loudness } i$$

$$+ 1.07885872 \times \text{sharpness } i + 9.27879937 \times \text{tonality } i$$

$$+ 2.89529674 \times \text{impulsiveness } i - 0.0155008 \times \text{ppm } i - 15.09832827$$

$$i = 1, 2, 3, \dots, n$$

ppm is a printing speed per minute for A4 horizontal size recording medium.

- 10 67. The image formation apparatus according to claim 66, wherein  
a multiple logistic regression model

$$\hat{P}_{ij} = 1 / \left\{ 1 + \exp \left[ - \left( \sum_{l=1}^L b_l (x_{li} - x_{lj}) \right) \right] \right\},$$

where

$b_l$  is regression coefficient

- 15  $x_{li}$  and  $x_{lj}$  are psychological acoustic parameter values of sounds that are  
compared in pair

$$i = 1, 2, 3, \dots, n$$

$$j = 1, 2, 3, \dots, n$$

$$l = 1, 2, 3, \dots, L,$$

- 20 that predicts a probability of dominance of sound based on a paired comparison of  
sounds transforms the expression (e) for calculating the discomfort probabilities into an  
expression that predicts a discomfort probability of single noise by using an average  
value of psycho-acoustics parameter values of whole samples that are used to derive

a regression model expression.

68. The image formation apparatus according to claim 66, wherein  
the discomfort probability  $P$ , in at least a direction of an operating section, of  
5 the sound generated by the image formation apparatus is at a permissible level or  
below, at a distance of  $1.00 \pm 0.03$  meters from an end surface of the image formation  
apparatus, and at a height of  $1.20 \pm 0.03$  meters above the floor or  $1.50 \pm 0.03$  meters  
above the floor.

10 69. The image formation apparatus according to claim 66, wherein  
an average value of the discomfort probability  $P$ , in four directions of front,  
back, left, and right sides, of the sound generated by the image formation apparatus is  
at a permissible level or below, at a distance of  $1.00 \pm 0.03$  meters from an end surface  
of the image formation apparatus, and at a height of  $1.20 \pm 0.03$  meters above the floor  
15 or  $1.50 \pm 0.03$  meters above the floor.

70. The image formation apparatus according to claim 66, wherein  
the discomfort probability  $P$ , on at least one side, of the sound generated by  
the image formation apparatus is at a permissible level or below, at a distance of  $1.00 \pm$   
20  $0.03$  meters from an end surface of the image formation apparatus, and at a height of  
 $1.20 \pm 0.03$  meters above the floor or  $1.50 \pm 0.03$  meters above the floor.

71. The image formation apparatus according to claim 66, wherein  
the discomfort probability  $P$ , on all the four sides, of the sound generated by  
25 the image formation apparatus is at a permissible level or below, at a distance of  $1.00 \pm$

0.03 meters from an end surface of the image formation apparatus, and at a height of  $1.20 \pm 0.03$  meters above the floor or  $1.50 \pm 0.03$  meters above the floor.

72. The image formation apparatus according to claim 66, comprising a  
5 higher-frequency-component reducing unit that reduces a  
higher-frequency-component to fulfill the condition (f).

73. The image formation apparatus according to claim 72, wherein  
the higher-frequency-component reducing unit includes a guiding member in  
10 a medium conveying unit and a sliding noise reducing unit that reduces sliding noise of  
the recording medium.

74. The image formation apparatus according to claim 66, comprising an  
impulse-noise reducing unit that reduces impulse noise to fulfill the condition (f).

15

75. The image formation apparatus according to claim 74, wherein  
the impulse noise reducing unit includes a medium conveyance control unit  
that controls electromagnetic clutches, each provided on each of routes for conveying  
a recording medium each having a plurality of medium feed trays, such that only  
20 electromagnetic clutches positioned on a used medium feed tray or above operate.

76. The image formation apparatus according to claim 66, comprising a  
pure-tone-component reducing unit that reduces a pure-tone-component to fulfill the  
condition (f).

25

77. The image formation apparatus according to claim 76, wherein  
the pure-tone-component reducing unit includes a charging noise reducing  
unit that reduces charging noise generated during a charging due to an AC bias.
- 5 78. The image formation apparatus according to claim 77, wherein  
the charging noise reducing unit has an eigen frequency of an image holder  
that is different from a frequency obtained by multiplying a natural number to a  
frequency of the AC bias.
- 10 79. The image formation apparatus according to claim 77, wherein  
the charging noise reducing unit has a sound absorbing member inside an  
image holder.
80. The image formation apparatus according to claim 77, wherein  
15 the charging noise reducing unit has an oscillation control member inside an  
image holder.
81. The image formation apparatus according to claim 66, comprising a guiding  
member in a route of a recording medium, wherein guiding member the includes a  
20 flexible sheet having a bent end edge portion or having a thickness of one half or  
smaller to control the conveying route of the recording medium.
82. A method of evaluating a sound generated by an image formation apparatus  
when forming an image onto a recording medium, the method comprising:  
25 recording an operation noise generated by each of a plurality of image

formation apparatuses each having a different image formation speed;

preparing a plurality of sample sounds from the operation noises;

measuring a psycho-acoustics parameter for each of the sample sounds;

evaluating the sample sounds using a paired comparison method;

- 5 carrying out a logistic regression analysis by using a discomfort probability of two kinds of sound using the evaluation of the sample sounds as objective variables and a difference of psycho-acoustics parameters as explanatory variables;

deriving a sound quality evaluation expression used to predict a probability of discomfort of sound based on a result of the logistic regression analysis; and

- 10 evaluating sound quality by using the sound quality evaluation expression.

83. The method according to claim 82, wherein the recording includes recording the operation noise binaurally.

- 15 84. The method according to claim 82, wherein the recording includes recording the operation noise of the image formation apparatus at a distance of  $1.00 \pm 0.03$  meters from an end surface of the image formation apparatus, and at a height of  $1.20 \pm 0.03$  meters above the floor or  $1.50 \pm 0.03$  meters above the floor.

- 20 85. The method according to claim 82, wherein the recording includes recording the operation noise from at least a direction in which an operating unit is provided in the image formation apparatus.



86. The method according to claim 82, wherein the recording includes recording the operation noise from four directions of front, back, left, and right sides of the image formation apparatus.

5 87. The method according to claim 82, wherein the preparing the sample sounds includes attenuating or emphasizing portions of main sound sources, on a frequency axis or a time axis, from the operation noises.

88. The method according to claim 82, wherein the preparing the sample sound  
10 includes attenuating or emphasizing portions of at least one of main sound sources of metal impulse noise, medium impulse noise, medium sliding noise, motor driving noise, and charging noise, on a frequency axis or a time axis, from the operation noises.

89. The method according to claim 82, wherein the psycho-acoustics parameters  
15 include one or more of a loudness value, a sharpness value, a tonality value, an impulsiveness value, a roughness value, a relative approach value, and a sound quality level value.

90. The method according to claim 82, wherein the evaluating the sample sound  
20 includes evaluating the sample sounds for each image formation speed using a paired comparison method.

91. The method according to claim 82, wherein the evaluating the sound quality includes  
25 deriving an expression (i) concerning a discomfort probability of sound from a

result of the logistic regression analysis,

$$\hat{P}_{ij} = 1 / \left\{ 1 + \exp \left[ \begin{array}{l} -0.650842(\chi_{\text{loudness } i} - \chi_{\text{loudness } j}) - 1.022138(\chi_{\text{sharpness } i} - \chi_{\text{sharpness } j}) \\ -12.08128(\chi_{\text{tonality } i} - \chi_{\text{tonality } j}) - 3.595879(\chi_{\text{impulse } i} - \chi_{\text{impulse } j}) \end{array} \right] \right\} \dots (i)$$

substituting an average value of the psycho-acoustics parameter values used to derive the expression (i) into the expression (i), thereby to derive the sound quality evaluation expression.

92. The method according to claim 91, wherein the evaluating the sound quality includes

deriving the expression (i); and

10 substituting an average value of psycho-acoustics parameter values used to derive the expression (i) into the expression (i) while taking the probability (P) to be 0.5.

93. The method according to claim 82, wherein the deriving the sound quality evaluation expression includes

15 deriving an expression (j) concerning a discomfort probability of sound from a result of the logistic regression analysis,

$$P = \frac{1}{1 + \exp(-z)} \dots (j)$$

where

$z = 0.12808364 \times (\text{sound pressure level } i - \text{sound pressure } j)$

20  $+ 0.47043907 \times (\text{loudness } i - \text{loudness } j)$

$+ 1.785872 \times (\text{sharpness } i - \text{sharpness } j)$

$+ 9.27879937 \times (\text{tonality } i - \text{tonality } j)$

$+ 2.89529674 \times (\text{impulsiveness } i - \text{impulsiveness } j)$

$$- 0.0114246 \times (\text{ppm } i - \text{ppm } j)$$

$$- 0.0040762 \times (\text{ppm average value } i - \text{ppm average value } j)$$

where ppm is a printing speed per minute for A4 horizontal size recording medium; and

deriving the sound quality evaluation expression by substituting an average  
 5 value of the psycho-acoustics parameter values used to derive the expression (j) into  
 the expression (j).

94. The method according to claim 93, wherein the deriving the sound quality  
 evaluation expression includes

10 deriving the expression (j); and

deriving the sound quality evaluation expression by substituting a total  
 average value of psycho-acoustics parameter values, a printing speed per minute for  
 A4 horizontal size recording medium, and an average value of the printing speed that  
 are used to derive the expression (j) into the expression (j), while taking the probability  
 15 (P) to be 0.5.

95. A method of manufacturing an image formation apparatus, comprising:

a design step of designing each section of the apparatus so that a discomfort  
 probability (P) calculated according to the expression (k) fulfills the condition (l) by using  
 20 a loudness value, a sharpness value, a tonality value, and an impulsiveness value of  
 psycho-acoustics parameters obtained from sounds that the image formation  
 apparatus emits at the time of forming an image onto a recording medium, the sounds  
 being collected at a position with a distance from an end surface of the image  
 formation apparatus,

$$25 \quad \hat{P}_{im} = 1 / \{1 + \exp[-z]\} \quad \dots (k)$$

$$\hat{P}_{im} \leq 0.2725 \ln(\text{ppm}) - 0.6331 \quad \dots (I)$$

where

$$z = A \times \text{sound pressure level } i + B \times \text{loudness } i + C \times \text{sharpness } i \\ + D \times \text{tonality } i + \text{impulsiveness } i + F$$

$$i = 1, 2, 3, \dots, n$$

A, B, C, D, and E are regression coefficients of parameters, and F is intercept, and A, B, C, D, E, and F satisfy the inequalities

$$0.142 \leq A \leq 0.183$$

$$0.300 \leq B \leq 0.389$$

$$1.097 \leq C \leq 1.265$$

$$9.818 \leq D \leq 11.516$$

$$2.588 \leq E \leq 3.240$$

$$-18.844 \leq F \leq 14.968;$$

and

a manufacturing step of manufacturing the image formation apparatus according to contents designed at the design step.

96. A method of manufacturing an image formation apparatus, comprising:

a design step of designing each section of the apparatus so that a discomfort probability (P) calculated according to the expression (m) fulfills the condition (I) by using a loudness value, a sharpness value, a tonality value, and an impulsiveness value of psycho-acoustics parameters obtained from sounds that the image formation apparatus emits at the time of forming an image onto a recording medium, the sounds being collected at a position with a distance from an end surface of the image formation apparatus,

$$\hat{P}_{i\omega} = 1/\left\{1 + \exp\left[\begin{array}{l} 16.90601 - 0.1625723\chi_{\text{sound pressure level}} \\ - 0.34475769\chi_{\text{loudness } i} - 1.18093783\chi_{\text{sharpness } i} \\ - 10.6669829\chi_{\text{tonality } i} - 2.91380546\chi_{\text{impulse } i} \\ \pm 2\hat{\sigma} \end{array}\right]\right\} \dots (m)$$

$$\hat{P}_{i\omega} \leq 0.2725\ln(\text{ppm}) - 0.6331 \dots (l)$$

where

$$i = 1, 2, 3, \dots, n;$$

5 and

a manufacturing step of manufacturing the image formation apparatus according to contents designed at the design step.

97. A method of manufacturing an image formation apparatus, comprising:

10 a design step of designing each section of the apparatus so that a discomfort probability (P) calculated according to the expression (n) fulfills the condition (l) by using a loudness value, a sharpness value, a tonality value, and an impulsiveness value of psycho-acoustics parameters obtained from sounds that the image formation apparatus emits at the time of forming an image onto a recording medium, the sounds  
15 being collected at a position with a distance from an end surface of the image formation apparatus;

$$\hat{P}_{i\omega} = 1/\left\{1 + \exp\left[\begin{array}{l} 16.90601 - 0.1625723\chi_{\text{sound pressure level}} \\ - 0.34475769\chi_{\text{loudness } i} - 1.18093783\chi_{\text{sharpness } i} \\ - 10.6669829\chi_{\text{tonality } i} - 2.91380546\chi_{\text{impulse } i} \end{array}\right]\right\} \dots (n)$$

$$\hat{P}_{i\omega} \leq 0.2725\ln(\text{ppm}) - 0.6331 \dots (l)$$

where

20  $i = 1, 2, 3, \dots, n;$

and

a manufacturing step of manufacturing the image formation apparatus according to contents designed at the design step.

98. A method of manufacturing an image formation apparatus, comprising:

- 5 a design step of designing each section of the apparatus so that a discomfort probability (P) calculated according to the expression (o) fulfills the condition (p) by using a loudness value, a sharpness value, a tonality value, an impulsiveness value, and a printing speed ppm for A4 horizontal size medium per minute, of psycho-acoustics parameters obtained from sounds that the image formation
- 10 apparatus emits at the time of forming an image onto a recording medium, the sounds being collected at a position with a distance from an end surface of the image formation apparatus,

$$P = \frac{1}{1 + \exp(-z)} \quad \dots (o)$$

$$P \leq 0.1728 e^{0.0065 \text{ ppm}} \quad \dots (p)$$

15 where

$$z = A \times \text{sound pressure level } o + B \times \text{loudness } i + C \times \text{sharpness } i$$

$$+ D \times \text{tonality } i + E \times \text{impulsiveness } i + F \times \text{ppm } i + G$$

$$i = 1, 2, 3, \dots, n$$

A, B, C, D, E, and F are regression coefficients of parameters, and G is

20 intercept, and A, B, C, D, E, F, and G satisfy the inequalities

$$0.10547717 \leq A \leq 0.15069022$$

$$0.40687921 \leq B \leq 0.53399976$$

$$0.99138725 \leq C \leq 1.166331$$

$$8.38547981 \leq D \leq 10.1721249$$

$$2.57373312 \leq E \leq 3.21686388$$

$$-0.020344 \leq F \leq 0.0106576$$

$$-17.49359273 \leq G \leq 12.70308101;$$

and

5 a manufacturing step of manufacturing the image formation apparatus according to contents designed at the design step.

99. A method of manufacturing an image formation apparatus, comprising:  
a design step of designing each section of the apparatus so that a discomfort  
10 probability (P) calculated according to the expression (q) fulfills the condition (p) by  
using a loudness value, a sharpness value, a tonality value, an impulsiveness value,  
and a printing speed ppm for A4 horizontal size medium per minute, of  
psycho-acoustics parameters obtained from sounds that the image formation  
apparatus emits at the time of forming an image onto a recording medium, the sounds  
15 being collected at a position with a distance from an end surface of the image  
formation apparatus,

$$P = \frac{1}{1 + \exp(-z \pm 2\sigma)} \quad \dots (q)$$

$$P \leq 0.1728e^{0.0065 \text{ ppm}} \quad \dots (p)$$

where

20  $z = 0.12808364 \times \text{sound pressure level } i + 0.47043907 \times \text{loudness } i$   
 $+ 1.07885782 \times \text{sharpness } i + 9.27879937 \times \text{tonality } i$   
 $+ 2.89529674 \times \text{impulsiveness } i - 0.01558008 \times \text{ppm } i - 15.09832827$   
 $i = 1, 2, 3, \dots, n$   
 $\sigma$  is standard error = 0.871894;

and

a manufacturing step of manufacturing the image formation apparatus according to contents designed at the design step.

- 5 100. A method of manufacturing an image formation apparatus, comprising:  
a design step of designing each section of the apparatus so that a discomfort probability (P) calculated according to the expression (r) fulfills the condition (p) by using a loudness value, a sharpness value, a tonality value, an impulsiveness value, and a printing speed ppm for A4 horizontal size medium per minute, of  
10 psycho-acoustics parameters obtained from sounds that the image formation apparatus emits at the time of forming an image onto a recording medium, the sounds being collected at a position with a distance from an end surface of the image formation apparatus,

$$P = \frac{1}{1 + \exp(-z)} \quad \dots (r)$$

15  $P \leq 0.1728e^{0.0065 \text{ ppm}} \quad \dots (p)$

where

$$\begin{aligned} z = & 0.12808364 \times \text{sound pressure level } i + 0.47043907 \times \text{loudness } i \\ & + 1.07885872 \times \text{sharpness } i + 9.27879937 \times \text{tonality } i \\ & + 2.89529674 \times \text{impulsiveness } i - 0.0155008 \times \text{ppm } i - 15.09832827; \end{aligned}$$

20 and

a manufacturing step of manufacturing the image formation apparatus according to contents designed at the design step.



101. A method of remodeling an image formation apparatus comprising:

a sound collecting step of collecting sounds that the image formation apparatus emits at the time of forming an image onto a recording medium, at a sound collection position with a distance from an end surface of the image formation

5 apparatus to be remodeled; and

a remodeling step of remodeling a configuration of the apparatus so that a probability (P) calculated according to the expression (s) fulfills the condition (t) by using a loudness value, a sharpness value, a tonality value, and an impulsiveness value of psycho-acoustics parameters obtained from a result of the sound collected at the

10 sound collecting step, where

$$\hat{P}_{i\omega} = 1/\{1 + \exp[-z]\} \quad \dots (s)$$

$$\hat{P}_{i\omega} \leq 0.2725 \ln(\text{ppm}) - 0.6331 \quad \dots (t)$$

where

$$z = A \times \text{sound pressure level } i + B \times \text{loudness } i$$

$$15 \quad + C \text{ sharpness } i + D \times \text{tonality } i + E \times \text{impulsiveness } i + F$$

$$i = 1, 2, 3, \dots, n$$

A, B, C, D, and E are regression coefficients of parameters, and F is intercept,

and A, B, C, D, E, and F satisfy the inequalities

$$0.142 \leq A \leq 0.183$$

$$20 \quad 0.300 \leq B \leq 0.389$$

$$1.097 \leq C \leq 1.265$$

$$9.818 \leq D \leq 11.516$$

$$2.588 \leq E \leq 3.240$$

$$-18.844 \leq F \leq 14.968.$$

25

102. A method of remodeling an image formation apparatus comprising:  
a sound collecting step of collecting sounds that the image formation  
apparatus emits at the time of forming an image onto a recording medium, at a sound  
collection position with a distance from an end surface of the image formation  
5 apparatus to be remodeled; and

a remodeling step of remodeling a configuration of the apparatus so that a  
probability (P) calculated according to the expression (u) fulfills the condition (t) by  
using a loudness value, a sharpness value, a tonality value, and an impulsiveness  
value of psycho-acoustics parameters obtained from a result of the sound collected at

10 the sound collecting step, where

$$\hat{P}_{im} = 1 / \left\{ 1 + \exp \left[ \begin{array}{l} 16.90601 - 0.1625723\chi_{\text{sound pressure level}} \\ - 0.34475769\chi_{\text{loudness } i} - 1.18093783\chi_{\text{sharpness } i} \\ - 10.6669829\chi_{\text{tonality } i} - 2.91380546\chi_{\text{impulse } i} \\ \pm 2\hat{\sigma} \end{array} \right] \right\} \dots (u)$$

$$\hat{P}_{im} \leq 0.2725 \ln(\text{ppm}) - 0.6331 \dots (t)$$

where

$$i = 1, 2, 3, \dots, n$$

15  $\sigma$  is standard error.

103. A method of remodeling an image formation apparatus comprising:  
a sound collecting step of collecting sounds that the image formation  
apparatus emits at the time of forming an image onto a recording medium, at a sound  
20 collection position with a distance from an end surface of the image formation  
apparatus to be remodeled; and

a remodeling step of remodeling a configuration of the apparatus so that a  
probability (P) calculated according to the expression (v) fulfills the condition (t) by using

a loudness value, a sharpness value, a tonality value, and an impulsiveness value of psycho-acoustics parameters obtained from a result of the sound collected at the sound collecting step.

$$\hat{P}_{im} = 1 / \left\{ 1 + \exp \left[ \begin{array}{l} 16.90601 - 0.1625723 \chi_{\text{sound pressure level}} \\ - 0.34475769 \chi_{\text{loudness } i} - 1.18093783 \chi_{\text{sharpness } i} \\ - 10.6669829 \chi_{\text{tonality } i} - 2.91380546 \chi_{\text{impulse } i} \end{array} \right] \right\} \quad \dots (v)$$

$$5 \quad \hat{P}_{im} \leq 0.2725 \ln(\text{ppm}) - 0.6331 \quad \dots (t)$$

where

$$i = 1, 2, 3, \dots, n.$$

104. A method of remodeling an image formation apparatus comprising:

10 a sound collecting step of collecting sounds that the image formation apparatus emits at the time of forming an image onto a recording medium, at a sound collection position with a distance from an end surface of the image formation apparatus to be remodeled; and

a remodeling step of remodeling a configuration of the apparatus so that a  
15 probability (P) calculated according to the expression (w) fulfills the condition (x) by using a loudness value, a sharpness value, a tonality value, an impulsiveness value, and a printing speed ppm for A4 horizontal size medium per minute, of psycho-acoustics parameters obtained from a result of the sound collected at the sound collecting step,

$$20 \quad P = \frac{1}{1 + \exp(-z)} \quad \dots (w)$$

$$P \leq 0.1728 e^{0.0065 \text{ ppm}} \quad \dots (x)$$

where

$$z = A \times \text{sound pressure level } i + B \times \text{loudness } i + C \times \text{sharpness } i$$

$$+ D \times \text{tonality } i + E \times \text{impulsiveness } i + F \times \text{ppm } i + G$$

$$i = 1, 2, 3, \dots, n$$

A, B, C, D, E, and F are regression coefficients of parameters, and G is

5 intercept, and A, B, C, D, E, F, and G satisfy the inequalities

$$0.10547717 \leq A \leq 0.15069022$$

$$0.40687921 \leq B \leq 0.53399976$$

$$0.99138725 \leq C \leq 1.166331$$

$$8.38547981 \leq D \leq 10.1721249$$

10  $2.57373312 \leq E \leq 3.21686388$

$$-0.020344 \leq F \leq 0.0106576$$

$$-17.49359273 \leq G \leq 12.70308101$$

ppm is a printing speed per minute for A4 horizontal size recording medium.

15 105. A method of remodeling an image formation apparatus comprising:

a sound collecting step of collecting sounds that the image formation

apparatus emits at the time of forming an image onto a recording medium, at a sound

collection position with a distance from an end surface of the image formation

apparatus to be remodeled; and

20 a remodeling step of remodeling a configuration of the apparatus so that a

probability (P) calculated according to the expression (y) fulfills the condition (x) by

using a loudness value, a sharpness value, a tonality value, an impulsiveness value,

and a printing speed ppm for A4 horizontal size medium per minute, of

psycho-acoustics parameters obtained from a result of the sound collected at the

25 sound collecting step,

$$P = \frac{1}{1 + \exp(-z \pm 2\sigma)} \quad \dots (y)$$

$$P \leq 0.1728e^{0.0065 \text{ ppm}} \quad \dots (x)$$

where

$$z = 0.12808364 \times \text{sound pressure level } i + 0.47043907 \times \text{loudness } i$$

$$+ 1.07885872 \times \text{sharpness } i + 9.27879937 \times \text{tonality } i$$

$$+ 2.89529674 \times \text{impulsiveness } i - 0.0155008 \times \text{ppm } i - 15.09832827$$

$$i = 1, 2, 3, \dots, n$$

$$\sigma \text{ is standard error} = 0.871894$$

ppm is a printing speed per minute for A4 horizontal size recording medium.

10

106. A method of remodeling an image formation apparatus comprising:

a sound collecting step of collecting sounds that the image formation

apparatus emits at the time of forming an image onto a recording medium, at a sound collection position with a distance from an end surface of the image formation

15 apparatus to be remodeled; and

a remodeling step of remodeling a configuration of the apparatus so that a

probability (P) calculated according to the expression (z) fulfills the condition (x) by

using a loudness value, a sharpness value, a tonality value, an impulsiveness value, and a printing speed ppm for A4 horizontal size medium per minute, of

20 psycho-acoustics parameters obtained from a result of the sound collected at the sound collecting step, where

$$P = \frac{1}{1 + \exp(-z)} \quad \dots (z)$$

$$P \leq 0.1728e^{0.0065 \text{ ppm}} \quad \dots (x)$$

where

$$\begin{aligned} z = & 0.12808364 \times \text{sound pressure level } i + 0.47043907 \times \text{loudness } i \\ & + 1.07885872 \times \text{sharpness } i + 9.27879937 \times \text{tonality } i \\ & + 2.89529674 \times \text{impulsiveness } i - 0.0155008 \times \text{ppm } i - 15.09832827 \end{aligned}$$

5  $i = 1, 2, 3, \dots, n.$